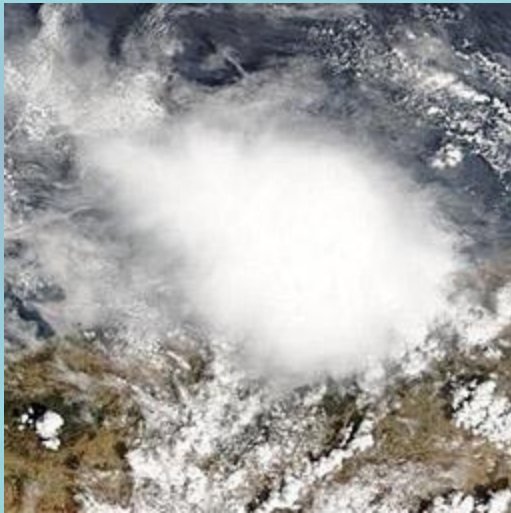


SCIENCE FOCUS: Hazardous Algal Blooms

Bad Bloom Rising

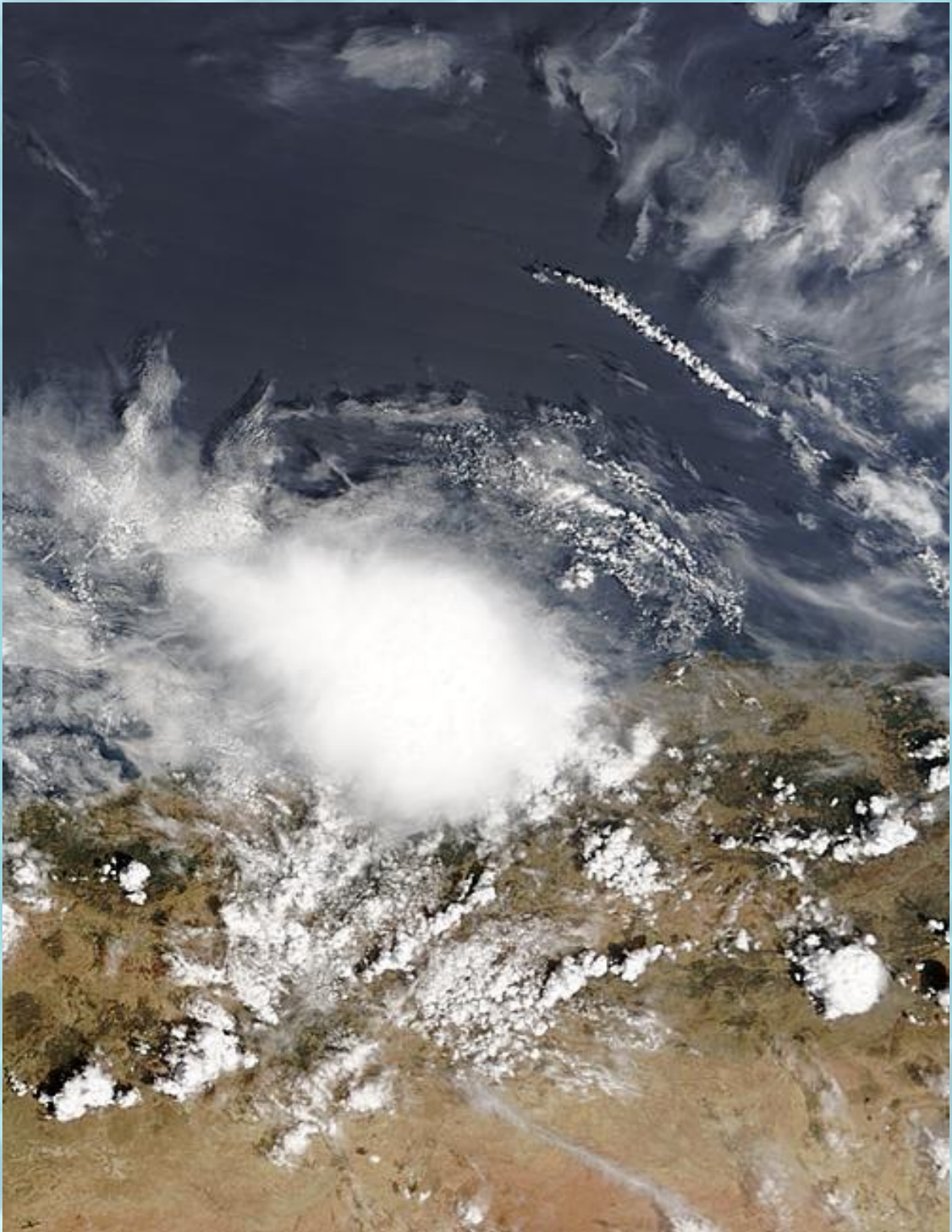
The remarkable sequence of images shown below was captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on the Terra and Aqua platforms on August 10-13, 2003. On August 10, a very large thunderstorm complex over Algeria produced immense amounts of rain that were quite unusual for this arid desert region. Local flooding was reported. On the following days, MODIS observed the development of a phytoplankton bloom originating in the semi-circular bay that is surrounded by Algiers, the capitol city of Algeria.

On the next four pages, the full image for each day is shown.



Sequence of MODIS images showing the development of a phytoplankton bloom in the Mediterranean Sea off of Algiers. Top left: Storm over Algiers, August 10, 2003. Top right: Image of bloom, August 11, 2003. Bottom left: Image of bloom, August 12, 2003. Bottom right: Image of bloom, August 13, 2003. Clicking each image will provide the full 500-meter resolution image.

August 10, 2003



August 11, 2003



August 12, 2003



August 13, 2003



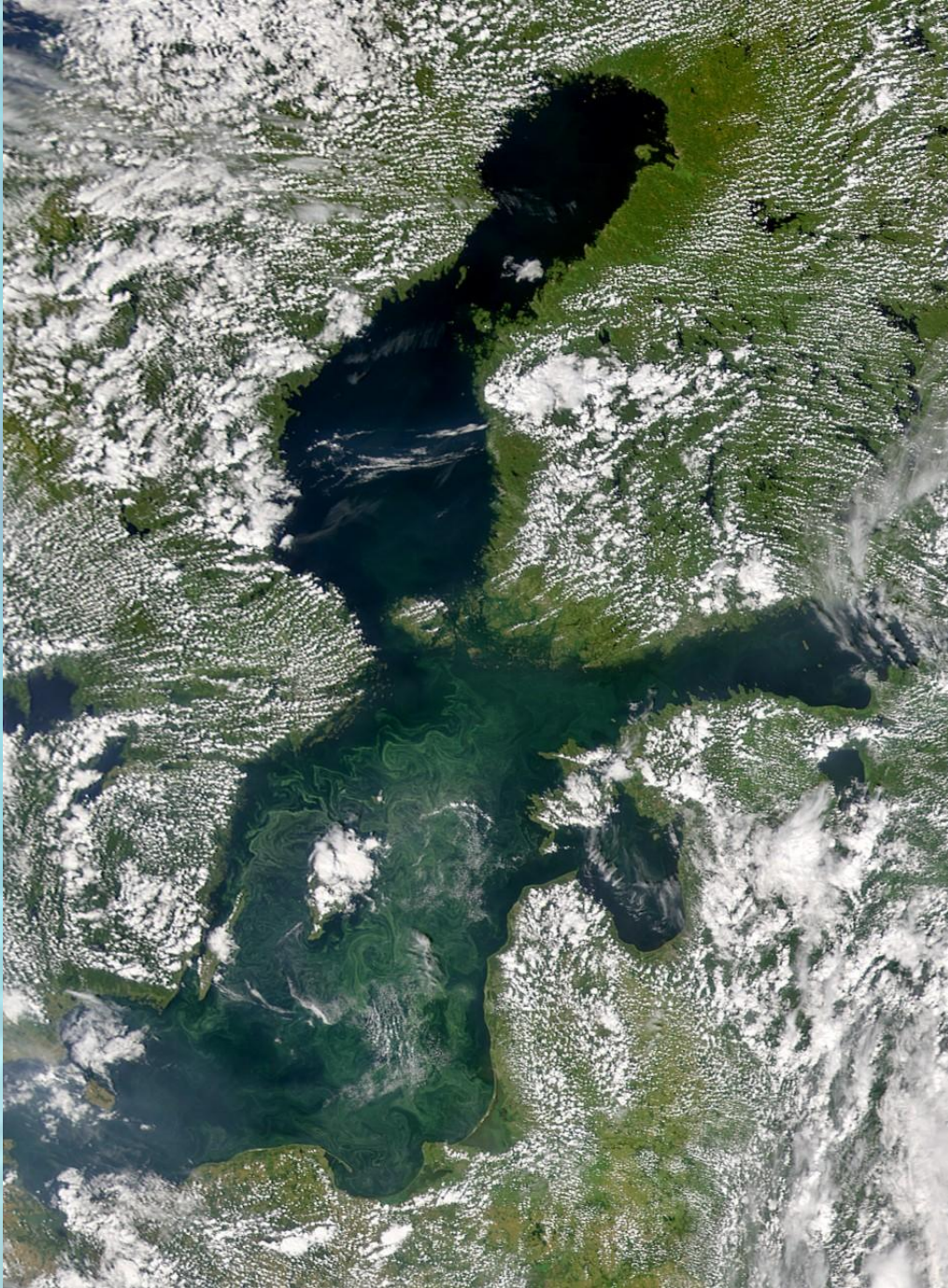
Phytoplankton blooms normally occur in response to either an increased supply of nutrients, or an increase amount of sunlight. In the southern Mediterranean Sea off the coast of Africa, sunlight is rarely in short supply, but nutrients usually are. The Mediterranean is actually a low-productivity body of water, and the clarity of the Mediterranean waters is renowned for this reason.

The thunderstorm seen in the first image must have caused a large amount of storm water to run off of the hills and streets of Algeria and into the Bay of Algiers. It is also possible that sewage treatment facilities were overwhelmed by the volume of storm water, causing the release of untreated sewage into the bay. (There are no reports of this happening, but similar problems can still occur for sewage treatment plants in the United States under high flow conditions caused by storms.) The storm water carried with it a high nutrient load from the dust, dirt, and debris that it received from the surrounding land. Opportunistic phytoplankton immediately utilized this transient nutrient supply to create the rapid population growth characteristic of a bloom. As the water was carried out to sea, the bloom went with it, slowly dissipating as the water dispersed and as the phytoplankton exhausted the nutrients in the pulse of storm water.

Most of the phytoplankton blooms occurring in the oceans are induced by natural causes and seasonal cycles. The North Atlantic Bloom is the largest seasonal bloom observed every year, but there are also large blooms in the Arabian Sea due to the monsoon cycle, and increases in productivity associated with the rainy season in South America can be seen emanating from the mouths of the Orinoco and Amazon rivers. Because these blooms take place due to natural processes, it's possible to call them "good" blooms.

However, the activities of mankind are causing an increasing incidence of what can be termed "bad" blooms: blooms induced by high nutrient concentrations due to pollution, enhanced runoff due to loss of vegetative cover and erosion, or agriculture. These blooms, rather than enhancing oceanic productivity, tend to interrupt the natural cycle, providing an overabundance of organic matter to the ocean bottom (see "Creeping Dead Zones") and frequently enhancing the growth of noxious or toxic phytoplankton.

This problem is particularly acute in what are called enclosed oceanic basins. The Mediterranean Sea is one example of an enclosed oceanic basin; the Baltic Sea is another. The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) image below shows an immense bloom of toxic phytoplankton in the Baltic Sea.



SeaWiFS image of the Baltic Sea acquired on July 24, 2003, by station HDUN at the University of Dundee, Scotland. A bloom of *Nodularia spumigena* is seen covering a large portion of the southern Baltic Sea.

The species which causes this bloom in the Baltic Sea, *Nodularia spumigena*, is a species of blue-green algae. *Nodularia* produces a hepatotoxin, a substance that can damage the liver. When such blooms are present, swimmers are cautioned not to ingest the water, and dog owners should keep their pets away from the water to avoid possible poisoning. Blue-green algal blooms can also cause skin irritation.

An important aspect of enclosed oceanic basins is the limited rate of exchange (renewal) of water that lies within them with the adjacent ocean. The routes of water exchange from the Mediterranean are through the narrow straits of Gibraltar to the Atlantic, the even narrower Dardanelles, leading to the Black Sea through the Bosphorus Strait, and a miniscule flow through the Suez Canal. The Baltic Sea outflow and water exchange is restricted through the contorted Skaggerak and the passages around the islands that are part of the country of Denmark. (The new [Oresund Bridge](#) between Denmark and Sweden may have further restricted the flow of water here.)

In either case, these restricted passages for the exchange of water mean that nutrients and other forms of pollution are not purged rapidly from these bodies of water. Increasing concentrations of nutrients foster larger and more prolonged phytoplankton blooms; other forms of pollution may enter the ecosystem and affect it detrimentally (such as the buildup of metals like cadmium and mercury in the trophic levels of the oceanic food web).

Another problem with "bad blooms" is their effect on coral reefs. Many of the world's most beautiful and extensive coral reefs lie adjacent to Third World countries with burgeoning populations, particularly along the coast. As excess nutrients, storm water runoff, and untreated or poorly treated sewage enter coastal waters, they also foster increased concentrations of phytoplankton. These algal blooms cause the overlying water to become increasingly turbid, and because corals require extremely clear water for their existence, this turbid water slowly extinguishes many coral species. Excess nutrient concentrations may also encourage the growth of encrusting macroalgae directly on the coral, as shown below, even in waters that appear relatively clear and pristine. Furthermore, sewage can carry with it bacteria and viruses that can induce coral diseases, which may cause rapid die-off of living coral formations.

Healthy coral reef environment



Coral covered with macroalgae



Remote sensing cannot, by itself, stop the processes that are causing the rise of "bad blooms", but the data from instruments like SeaWiFS and MODIS can be used to monitor these events, determine their likely causes, and aid in the identification of methods to reduce their incidence and severity.

Acknowledgements

This Science Focus! article acknowledges the contributions of the references linked below, the MODIS Rapid Response Team and Norman Kuring of the SeaWiFS Project for the MODIS and SeaWiFS images.

Links

- [Nodularia spumigena blooms and the occurrence of hepatoxin in the Gulf of Gdansk \(PDF Document\)](#)
- [Nodularia spumigena](#) (Baltic Sea Phytoplankton Sheet)
- [Nodularia spumigena microphotographs](#)
- [View of a Nodularia spumigena bloom from underwater](#)
- [Pictures of Nodularia spumigena blooms](#)
- [Global Coral Reef Alliance](#)
- [Mapping the Decline of Coral Reefs](#)